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ONTARIO

Department of Education

Courses of Study

Grades IX, X, XI and XII

SHOP COURSES IN VOCATIONAL SCHOOLS

Issued by Authority of
The Minister of Education

SUGGESTIONS FOR THE USE OF THE COURSES

Outlines for the shop courses in vocational schools are provided herein. They are designed for the maximum shop-work time as set forth in the Regulations, and on the assumption that five shop subjects will be offered in Grade IX. In schools where a larger or smaller number of shop subjects is offered the courses should be modified to suit the time available. In schools where it may be desirable to teach courses not specified in the outlines a synopsis of such courses of study shall be submitted for the approval of the Minister.

The project is the usual means of shop instruction. Projects to cover the topics of the course should be selected with a view to the interests and abilities of the pupils and should offer sufficient variety. The well-directed use by the pupils of carefully planned shop libraries, illustrative materials and other lesson aids will promote the close co-ordination of intelligent study with the performance of recognized trade operations.

The variety and quantity of the equipment available will determine the selection and arrangement of the topics from the following courses of study. From these courses the teacher should make a detailed organization of the work for each class. Frequent and systematic appraisal of the pupils' work should be made.

Pupils majoring in a shop subject shall take related shop subjects. To conserve shop time for shop work, the science, mathematics and drafting related to the various shop courses should be taken in the respective departments.

In all courses definite information with respect to the opportunities in the various related occupations and the particular job requirements should be made available to the pupils in order to assist them to make a wise choice of their future vocations.

Dangerous conditions affecting the health and safety of pupils in school must be avoided. Exhaust gases from running engines and fumes from spray guns and heat-treating processes must be effectively discharged. All machines must be properly guarded, safety instruction must be given in every shop where hazards exist, and a first-aid cabinet must be readily accessible. A clean and well-appointed shop, with equipment maintained in first-class operating condition, is an important factor in the prevention of accidents.

COURSES OF STUDY

GRADE IX

Exploratory Nature of the Courses

Pupils enrolled in a Vocational Shop Course are given training in a variety of shops in Grade IX, so that before entering the higher grades they may be able to select a particular shop in which they may complete the preparatory training necessary for admission to the trades and the industries.

DRAFTING

1. Development of Drafting Skills:

- (a) The use and care of the elementary drafting instruments: T-square, set squares, pencil, scale, compasses.
- (b) The recognition, through use, of the following: outline, hidden outline, centre line, projection line, extension line, dimension line and arrow head.
- (c) The development of skill in single stroke freehand lettering: alphabet, figures, and fractions; size, slant and spacing, horizontal and slant guide lines. Application in notes and dimensions.

2. Working Drawings:

- (a) Freehand sketching of orthographic views from pictorial representations and objects to illustrate the correct placement of views on working drawings and the difference between working drawings and picture drawings.
- (b) Two and three-view working drawings to full size, or to scale 3 inches = 1 foot, of:
 - (1) Simple rectangular objects.
 - (2) Angular objects which require straight lines only, such as wedges and tapers.
 - (3) Objects with curved surfaces involving circles and parts of circles; the locating and dimensioning of circular openings and holes.
- (c) Dimensioning.
- (d) Sections and half-sections; methods of indicating the section and the materials by cross-hatching.
- (e) Geometrical constructions as required.

3. Detail and Assembly Drawings:

- (a) Assembly drawings of objects selected from the woodworking field; plan view, front view, side view, sections and scales as required.
- (b) Detail drawings of simple machine parts to illustrate conventional indications for shop operations such as drilling, threading, tapping and finishing.

4. Development of Surfaces:

Developing patterns for rectangular objects; parallel line development of patterns for cylinders (right and oblique cut), two-piece elbows and scoops.

5. Blueprint Reading:

Examining simple drawings and blueprints of shop projects and other objects to learn the sizes, shapes, details, materials and processes as specified.

APPLIED ELECTRICITY

1. Circuits:

- (a) A complete circuit installation consisting of supply of current (dry cells or 6-volt battery), conductors, switch or push button, and load (sockets and lamps, or bell or buzzer).
- (b) A circuit with a fixed load in which dry cells as a source of current may be added one at a time, (1) in series, (2) in parallel, and the general effect on the load observed and recorded.
- (c) A circuit with a fixed source of current and the load units added one at a time, (1) in series, (2) in parallel, and the general effect observed and recorded.
- (d) An annunciator circuit installation; other elementary signal circuits.

2. Joints, Soldering, Weatherproofing:

- (a) Making simple joints such as rat-tail, tee, and western union.
- (b) Soldering, preparation of soldering iron and use of flux in soldering joints.
- (c) Weatherproofing: taping and the use of compound.

3. Magnetism and Electro-magnetism:

- (a) Magnetic field about permanent magnets examined by use of iron filings or small compasses; study of polarity.
- (b) Making an electro-magnet; study of the magnetic field and polarity.
- (c) Examination of the field of force about a single wire carrying a current of electricity; development of "right hand rule."

4. Study of action of electric bells, buzzers, and annunciators.

5. Conductors and insulators: experimental study of a few common metals and non-metals as a basis for classification into conductors and insulators.

6. Circuit protection: heating effect of electric current; construction, purpose and rating of simple fuses (plug and cartridge type); an experiment to show safe current; carrying capacity of standard wires and cables used in the home.

7. Electrical units: sufficient experimental acquaintance with elementary circuits to gain the concept of volt, ampere, ohm, and watt.

8. Cost of electrical energy: determining the cost of operating common household heating appliances from name-plate reading; reading the kilowatt-hour meter and computing the cost of electrical energy.
9. Electrical equipment in the home: some general suggestions to get the best use from equipment such as heating appliances, lights and lighting equipment; electrical hazards and precautions to be taken.

MACHINE SHOP PRACTICE

1. Hand Tools and Bench Work:

- (a) Trade description of such tools and equipment required for this course as soft and hard hammers, chisel, punch, file, hack saw, taps and dies, and vise.
- (b) Operations such as sawing, use of hammer and chisel, filing, riveting, use of steel letters in marking, threading (taps and dies), edge and flat bending and forming.

2. Layout Work:

- (a) Coating of metal surfaces (copper sulphate, chalk) to facilitate layout.
- (b) Use of steel rule, dividers, scribe, hermaphrodite calipers, and punch in laying out work from blueprints or drawings; centering work for drilling.

3. Machine Operations:

- (a) Lathe:
 - (1) Identification of main parts only, such as headstock, tailstock, faceplate, centres, bed, carriage and controls.
 - (2) Setting up work in machine, side facing, rough turning; parting, turning to a shoulder, finish turning, use of calipers in turning to size, knurling, polishing and taper turning by offset method; use of chucks; end facing of work held in a chuck; lubrication of machine.
- (b) Drill press:
 - (1) Operation, lubrication and maintenance of the machine.
 - (2) Centre punching of location for drilling, securing material in vise or V-block, sizes of drills and method of attachment in chuck, use of cooling and cutting compounds; precautionary measures to prevent damage to table and vise.
 - (3) Drilling to a layout, drawing holes to a desired location, countersinking.
- (c) Grinder: safety precautions and use of goggles, rough grinding to remove hard skin of material, rough grinding to bring material to size.
- (d) Power hack saw: setting up work, cutting to length, use of lubricants for cutting.
- (e) Shaper: plain surfacing.

4. Fastenings:
 - (a) Bolt and nut; rivet, round and flat head.
 - (b) Rivet-driving; forming head using snap and counter-sunk heads.
5. Hot Metal Working:
 - (a) Operation of forge or furnace.
 - (b) Heating and working metals: simple exercises as required to complete project such as squaring round stock, drawing out a tang; effect of overheating.
 - (c) Simple hardening and tempering.
6. Finishing:

Polishing, rustproofing, painting and enamelling; preparation and application.

MOTOR MECHANICS

1. Chassis:
 - (a) Parts: examination and study to obtain the name, purpose and location of principal parts.
 - (b) Specifications: wheel base, spring suspension, steering-gear ratio, tread, and clearance.
2. Engine:
 - (a) Parts: identify parts, dismantle, and assemble a one-cylinder engine.
 - (b) Operation: events in the four-stroke cycle; combustion mixtures; properties and danger of carbon monoxide gas, precautions and artificial respiration.
3. Lubrication:

Simple theory; description, and examination of one system including dismantling and assembly.
4. Cooling System:

Radiator, pump, water-jackets; cooling fluids; examination of one system.
5. Electrical System:

Simple ignition system comprising battery, coil, breaker and spark plug. (To be confined to a one-cylinder engine; electrical circuit to be traced and operation observed without theory.)
6. Fuel System and Fuel:
 - (a) Tank, pump, fuel lines, simple carburetor; common fuel line troubles.
 - (b) Gasolene: use, precautions in its use, method of storing, methods of extinguishing fire; gasolene prohibited for cleaning purposes.
7. Fastenings:

Identification of bolts, nuts, cap screws, threads, rivets, washers, cotters; their use and application.

8. Transmission System:

- (a) Clutch: friction, single plate.
- (b) Gear box: standard positions, effect on drive shaft, speed ratios; elementary conception of mechanical advantage.
- (c) Drive shaft: types.
- (d) Rear axle: one type; differential, split axle, revolutions of wheels when turning corners, and gear reduction.

9. Running Gear:

- (a) Front axle: simple explanation; examination of unit for camber, caster, and toe-in.
- (b) Steering: one type, Ackerman principle.
- (c) Brakes: shoes, drums and linkages as applied to one wheel.

PRINTING

1. The California Job Case and Contents:

- (a) Character and purpose of the case.
- (b) The lower case letters, plan and reason for arrangement.
- (c) The capitals, numerals, punctuation marks, ligatures, signs, spaces and quads.

2. The Composing Stick:

- (a) Kinds, parts and adjustment; use, care, and posture for setting.
- (b) Pulling a proof in the stick.
- (c) Distribution from the stick.
- (d) Justification: simple flush lines.

3. Type:

- (a) Composition, parts, functions, fontage.
- (b) Characteristics of similar letters, how identified, type and print compared.
- (c) Point system of sizes and measurements.
- (d) Point system as applied to leads, slugs and other material.

4. Composition:

- (a) Spacing, justifying, centering, quadding.
- (b) Indention and justification as applied to regular paragraph work.
- (c) Poetry, flush, indented, turnovers, quotations.

5. Proofreading:

Correction of work with elementary introduction to the use of the principal marks and their meanings.

SHEET METAL

1. Materials:

- (a) Galvanized sheet iron and tin plate: reasons for different coatings on sheet iron, advantages and disadvantages of each coating; types of articles made from each metal; common stock sizes and gauges, comparison of thickness of sheets of different gauges used in the shop.
- (b) Solders: common (soft) solder, composition; reasons for different alloys used for solder; uses of common solder and special solders.
- (c) Soldering fluxes: purpose and reaction of soldering fluxes with common metals; types of fluxes used on common metals; the use of muriatic acid, sal-ammoniac, soldering paste and rosin; making zinc chloride (killed acid).

2. Hand Operations and Tools:

- (a) Laying out: use of squaring, measuring and marking tools; method of laying out from a straight edge and a centre line, use of templates; adding seaming allowances for lap and grooved seams, and reinforced edges.
- (b) Cutting: use of straight snips for cutting on straight lines and curved lines; notching and cutting for hinges; use of cutting pliers for wire cutting; care of cutting tools.
- (c) Folding and forming: proper use of mallet and setting hammer in forming metal over stakes; use of hollow mandrel, beakhorn or improvised stakes for bending along straight lines in the construction of simple straight-lined objects.
- (d) Wiring: allowance required for various sizes of wire used in reinforcing edges; preparatory bends, forming wire, use of mallet and setting hammers for hand wiring; necessary precautions to avoid damaging metal during wiring operations; location for ends of wire.
- (e) Grooving: use of hand groovers; seaming allowance required, width, type and direction of folds on edges to be joined; locking ends for proper alignment of folds; operation of grooving a seam.
- (f) Soldering:
 - (1) Soldering iron: purpose, conductivity of copper, oxidation, tinning a soldering iron.
 - (2) Soldering: heat required; correct position and movement of soldering iron over a seam, penetration of solder into a seam; fusing solder into a metal.

3. Machine Operations:

- (a) Foot squaring shears: cutting on a line, squaring stock; use of side, back and front gauges; types of material which may be cut in shears; safety precautions.
- (b) Adjustable bar folder: types of folds (open, close and double); setting and locking gauge; use of stops for various angles.
- (c) Bending brake: method of operating for bending material in the construction of simple straight-lined objects.

- (d) Roll former: feeding metal between rollers, adjusting rollers for tension on metal and for forming metal into cylindrical objects of various diameters.

4. Sheet metal finishes: methods of preparing various sheet metals to take protective and decorative finishes.

GENERAL WOODWORKING

The organization of the course should make provision for pupils with previous instruction in manual training in Grades VII and VIII, and tests should be given at the beginning of the school year to determine the pupils' knowledge of woodwork and their ability to perform elementary operations.

1. Materials:

- (a) Lumber: classification of lumber—open and close grain, general purpose and miscellaneous woods; stock sizes; units of measurements.
- (b) Glues: source, preparation and application.
- (c) Hardware: nails (common and finishing); wood screws—flat, oval and round-head; hinges—butt, strap and tee; various types of catches.
- (d) Finishing materials: elementary supplies; stain, shellac, paint and enamel.

2. Hand Tools and Operations:

- (a) Laying out: economical selection of stock; use of try-square, marking gauge and marking knife.
- (b) Sawing: rip and cross-cut.
- (c) Planing: surfaces, edges, ends; at an angle to grain, chamfering, rounding.
- (d) Chiselling: paring, chamfering, rounding; perpendicular chiselling; cutting a hand mortise; use of mallet.
- (e) Shaping: use of coping and compass saw; use of spokeshave and file.
- (f) Boring: use of brace, hand drill and various types of boring bits.
- (g) Fastening: use of common and finishing nails, screws, corrugated fasteners, clamp nails; use of various types of clamps.
- (h) Sanding: use of abrasives such as sand and garnet paper.
- (i) Sharpening: whetting plane irons and chisels.

3. Machine Tools and Operations:

The machines must be adequately guarded and the guards must be in place. Operations that cannot be completed with the guards in place must not be attempted.

- (a) Lathe: rough and finish turning to size; shoulder and taper turning, turning simple beads and curves; face-plate turning; use of calipers and templates.

- (b) Jig sawing: sawing simple scrolls.
 - (c) Band saw: use of saw in cutting curves; adjustment of guards.
 - (d) Mortiser: vertical mortising.
 - (e) Router: use of the hand router for simple moulds.
4. Finishing: preparation and application of stain, shellac, paint and enamel; application of wax (mission finish); care of brushes.
 5. Trimming: applying small knobs, hinges and catches over a finished surface.
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FARM MECHANICS

1. Drawing and Plan Reading:
 - (a) Measuring and sketching: simple objects in full scale to include placement of views, representation of visible and invisible surfaces, dimensioning and lettering; scale drawings, elementary geometrical construction and lettering as required.
 - (b) Reading blueprints: a study of complete drawings of simple, useful farm or home equipment to assist the pupils in picturing the object, locating dimensions and estimating the cost.
2. Woodwork:
 - (a) Common hand tools: construction, uses, adjustment and upkeep.
 - (b) Materials:
 - (1) Uses and recognition in the rough and the finished state of at least six woods; warping and checking of woods, how caused and counteracted.
 - (2) Identification of nails, wood screws and other hardware in common use.
 - (c) Operations: use of saw, plane, chisel, and try-square in squaring stock to size and making joints such as rabbet, mitre, mortise and tenon; the making of at least three articles useful in the home or garden or on the farm, such as bread-board, neck-tie rack, coat-hanger, flower trellis, bench-hook, nail box, milking stool, chicken feed hopper, bird house or harness-stitching clamp; the study of the tools and construction of the joints to be introduced in the pupils' projects.
3. Paints and finishes: paints for wood, iron, and concrete; home-mixed and ready-mixed paints; preparation of surfaces; the uses of shellac, varnish and wax in finishing; the care of brushes.
4. Rope work: kinds and grades of rope; uses of rope on the farm; care of rope; common knots and their uses; whipping a rope end, crowning and tucking a rope end; making a short splice, long splice and eye splice.
5. Belt lacing: leather and fabric belts; care of belts; tools required in belt lacing; making of samples of single lacing and double lacing using cardboard and cord.

6. Harness repairing: importance of keeping harness in good condition by cleaning, oiling and repairing at least once a year; tools and materials needed; making a waxed thread and practice in stitching splices; attaching snaps and buckles.
7. Glazing: tools, preparation of putty; value of priming coat on sash; methods of cutting glass; practice in putting glass in new sash or in replacing glass in a broken window.
8. Pipe-fitting:
 - (a) Kinds of pipe: black and galvanized iron.
 - (b) Operations: cutting, reaming, threading, sealing joints; use of couplings, elbows, tees, reducers; measuring runs and making layouts.

COURSES OF STUDY

GRADE X

Pupils enrolled in Vocational Schools may be given an opportunity in Grade X to select a particular shop in which they may, according to a plan outlined, continue the preparatory training necessary for admission to the trades and the industries.

DRAFTING

1. Working Drawings:

More advanced problems involving placement and dimensioning of views, auxiliary views, isolated and revolved sections, symbols of materials and bills of materials. The drawings to be selected from shop projects when suitable. The making of sketch plans before starting the scale drawings to be encouraged.

- (a) Architectural drawing: simple building details such as brickwork, foundations, walls, doors, windows, stairs, fireplaces and kitchen layouts; plans, sections and elevations of frame construction; details of a small frame structure such as garage, summer cottage or farm building; conventional representations used on floor plans for details such as windows, doors, electrical outlets, plumbing and heating.
- (b) Machine drawing: detail drawings of handles, pulleys, face-plates, couplings, bearings, cranks, glands, fastenings or similar mechanical devices; conventional indications used in plan, elevation and section views for tapped, blind, bored, countersunk, counter-bored and cored holes; indications as required for other machine operations and for materials used in machine parts; detail and assembly drawings of simple machines such as the vise, clamp, and press; layout of pipe lines, calculation of lengths, selection of fittings for pipe handrails and pipe racks.

2. Orthographic Projection:

Problems to illustrate the principles of projection: objects with surfaces not parallel to one another, obliquely cut objects such as frustums of pyramids and cones; auxiliary views; incomplete views.

3. Intersection of Surfaces:

Plotting the lines of intersections of cylindrical and rectangular shapes joining at various angles such as in tee and branch pipes.

4. Development of Surfaces:

Radial line development applied to conical and pyramidal shapes; extension of parallel line development to three and four-piece elbows; developments involving a combination of both methods for pattern layout; allowances for laps and seams.

5. Geometrical Constructions:

Drafting problems involving such layouts as the hexagon, octagon, and pentagon, the division of circles and lines, and the bisection of angles and lines.

6. Isometric Drawing:

Principles of isometric drawing, the boxing and offset methods; circles in isometric.

7. Map or Topographical Drawing:

Drawing of a land plot from field sketch and notes; indications for topographical features.

8. Blueprint Reading:

Reading drawings representative of the shop work taught in the school and of the local industries. Problems to be arranged to require the preparation and study of lists of the materials and processes indicated on the drawings.

9. Tracing and Blueprinting:

For the student who makes rapid progress in drafting: inking, tracing and blueprinting.

NOTE:—Where pupils are allowed to major in either Architectural or Machine Drawing in Grade X, Part (a) or (b), Topic 1, is to be expanded. Where pupils are majoring in a designated shop, the drafting projects for these pupils are to be related to their shop work.

APPLIED ELECTRICITY

A. INSTALLATION AND MAINTENANCE

The course should be closely connected with, and the workmanship should conform to, the requirements of the Hydro-Electric Power Commission of Ontario.

1. Splices and Joints:

Proper construction and uses of common splices and joints including cable splicing, soldering, taping, and waterproofing; sweating of terminal lugs.

2. Materials:

Study of the B. and S. gauge wire tables; recognition of commonly used wires and cables according to size, insulation and use; identification by name, size and description of other trade materials within the scope of this course.

3. Circuits:

(a) Bell and annunciator circuits: ground return, parallel operation, return call, three or four-point annunciator, master control bell system, and other similar circuits.

(b) Light and power circuits: construction (knob and tube) of the elements of lighting circuits such as might be suitable for a seven-roomed house; construction in non-metallic sheathed wire and cable.

4. Testing and Repair:

Elementary testing and repair of simple electrical appliances. The testing referred to in this course is to be confined to the use of journeyman's test equipment.

B. THEORY AND TEST

1. Magnetism:

- (a) A more extensive study of this topic by the mapping of the fields of force about permanent magnets as used in electrical apparatus and equipment.
- (b) Plot fields of force about conductors carrying current to develop the right hand rule and helix rule; effect of increasing (1) turns, (2) current through a coil of wire having an iron core; electromagnetism as applied in electric bells, relays, circuit breakers, and lifting magnets; air gap, permeability, saturation and residual magnetism.

2. Conductors and Non-conductors:

A more advanced study and experimental determination of ability of common metals, non-metals, and solutions to conduct current.

3. Heating effect of electric current; circuit protective devices (fuses and thermal cut-outs).

4. Instruments (the D.C. ammeter and voltmeter):

Principal parts, construction, principles of operation, location in the circuit and precautions for proper use.

5. Ohm's Law (experimental study):

- (a) Effect on current in circuit by varying resistance and holding voltage constant.
- (b) Effect on current in circuit by varying voltage and holding resistance constant.
- (c) Development of equations.

6. Resistors, Resistance Measurement, Circular Mil Measure:

- (a) An examination and study of common resistance materials as found in household appliances, such as lamps, motors, motor starters and heaters.
- (b) Measurement of the resistance of such appliances by the volt-ammeter and Wheatstone bridge methods.
- (c) Comparison of wire diameters with standard tables; comparison of mil foot resistances of wires in common use.

7. Circuits:

Determination of current, voltage, and resistance characteristics of typical series and parallel circuits.

8. Voltage Drop:

Measurement of voltage drop in simple electric circuits for light, heat and power.

9. Measurement of Power:

Three methods: volt-ammeter, wattmeter (kilowatt-meter), and watt-hour (kilowatt-hour) meter; horse power in terms of kilowatts.

10. Losses in Electric Circuits:

Copper losses in field coils, armatures, and transmission lines.

11. The D.C. Generator:

- (a) Elementary laws governing the direction and relative values of induced currents in conductors cutting magnetic fields.
- (b) Simple D.C. shunt-wound generator, parts and their functions.
- (c) Characteristic tests; no load voltage characteristics with variation of field strength (separate constant excitation), variation of terminal voltage with variation of load current (self-excitation).

MACHINE SHOP PRACTICE

1. Hand Tools and Bench Work:

- (a) Use of different types of blades in the hand hack saw with a view to proper selection.
- (b) Filing to size with greater attempt at the production of flat surfaces.
- (c) Threading by use of taps and dies.

2. Layout Work:

- (a) Coating of metal surfaces to facilitate layout.
- (b) Use of scale, scribe, centre punch, calipers, surface plate and surface gauge.

3. Machine Operations:

- (a) Lathe: taper turning by means of taper attachment; spotting and drilling; filing and polishing; thread cutting—external N.C. thread.
- (b) Drill press: selection of proper drills (carbon and high speed) for different materials and speeds; use of various cutting agents for different materials; drilling to a depth; countersinking; finishing work by emery stick head; spot facing.
- (c) Shaper: shaping of horizontal, vertical, and irregular surfaces.
- (d) Miller: milling a flat surface.
- (e) Grinder: more detailed study of abrasives as to properties, selection and use; grinding lathe tool bits to sample and gauges.

4. Hot Metal Work and Elementary Metallurgy:

Forging, cutting, bending, punching, drawing, upsetting, hardening, tempering; shop tests for the distinguishing characteristics of common metals; machine and hand work in brass, bronze, and babbitt to acquaint pupils with the fundamental properties and uses of these alloys.

5. Fasteners:

An examination of such fasteners as rivets, bolts, cap screws, set screws, taper pins and keys for purposes of identification and knowledge of their special uses.

6. Repair and Maintenance:

- (a) Belts: care, selection, proper operation and splicing; power transmission.
- (b) Lubrication: bearing types; grease and oil fittings, and special lubrication required.

MOTOR MECHANICS

The course of study is to deal in greater detail with the names, purpose, location, and operation of the principal parts of the modern automobile, and to provide for simple fitting and adjusting during assembly and replacement operations. One or more running engines are required.

Safety instruction relating to the proper handling of machine and hand tools, gasoline and lubricants, including the stressing of the dangers of carbon monoxide gas, should be emphasized.

1. The Multi-cylinder Engine:

- (a) Piston assembly: relative position of pistons in various cylinders, relative piston pressures; detailed examination of pistons, rings, connecting rods and bearings.
- (b) Crankshaft: types, relation to stroke, r.p.m., length of stroke in degrees.
- (c) Valves: arrangement as to heads, seats, faces, springs, locking, guides, tappets and clearances; timing valves with and without marks; valve lap, lead and lag.
- (d) Horsepower: brief reference to horsepower formula as used for license purposes.

2. Lubrication:

Study of a lubrication system for modern automobile engine and chassis; kinds of lubricants, lubrication charts, S.A.E. gradings, effect of extreme temperatures, filters.

3. Cooling System:

Types, parts and function of each; anti-freeze solutions and testing.

4. Electrical System:

Identification of component parts for a four-cylinder engine, including ignition, generator, starter, and lighting circuits; wiring up of the above-mentioned circuits with and without wiring diagram, using unidentified wire.

5. Fuel System:

Fuel pumps, strainers, carburetor (detail adjustments on one type); fuel properties, significance of octane ratings.

6. Transmission System:

- (a) Clutch: detailed examination of a single-plate dry clutch; adjustment of clutch.
- (b) Gear box: path of power, relative speeds of crank and drive shaft for different gear shift positions; mechanical advantage, and direction of drive.
- (c) Drive shafts: examination of two types; need for universal joint, kinds of universal joints.
- (d) Rear axles: types; more detailed study of differential, including variation in speed of rear wheels due to resistance; gear reduction, ratio of speed of rear wheel to ring gear.

7. Running Gear:

- (a) Front axle: types; principal parts including king pins, steering knuckle, bearings, tie rod, drag link; more detailed study of Ackerman principle, including pivot or king pin inclination, camber, caster, toe-in and steering-gear reduction.
- (b) Brakes:
 - (1) Mechanical: a study of complete mechanical unit with linkage for four wheels.
 - (2) Hydraulic: a study of operation of master cylinder and wheel cylinder in actuating brake linkages.

PRINTING

1. Elementary Composition:

- (a) Dumping and tying up: methods, precautions and development of skill.
- (b) Pulling proofs on the galley: advantages, procedure and standard of cleanliness necessary.
- (c) Distributing from the galley.
- (d) Correcting in the stick and on the galley: general classification of corrections and proper procedure; special corrections, including over-running and leading.
- (e) Paragraph composition: rules for lines, indention, general procedure to gain uniform appearance and easy reading; justification.
- (f) Punctuation marks and spacing: standard practice for the spacing of the period, comma, hyphen, colon, semi-colon, exclamation, question, apostrophe, dash, parentheses, and brackets.

2. Proofreading: symbols, use of symbols in study of a proofread model, assigned proofreading.

3. Special Composition:

- (a) Setting poetry: special indentions, justification, general rules and exceptions.
- (b) Numbering sentences: alternate use of numbers and letters.

- (c) Setting indentions: review of regular paragraph indention and extension of study to include hanging, half-diamond, squared and diagonal.
 - (d) Setting numbers: three ways of expressing number, rules for comma, usage and examples of correct usage.
 - (e) Tabular composition: rules for procedure in setting up a simple example of tabulated form.
 - (f) Multiple justification: advantages and procedure.
 - (g) Initial letters: history, purpose, extent of use, rules for use in composition.
 - (h) Leaders and rules: examples, purpose, procedure for composition.
 - (i) Borders: purposes, common types, margins, procedure for making butted rule border and mitred border.
4. The point system: brief history, advantages, units, applications to types and materials.
5. Book Composition:
- A booklet in loose-leaf form introducing the following features of book composition: preliminary pages (title pages, advertising card, copyright, dedication, preface, contents, list of illustrations, introduction, half title); chapter heads, initial letters, running heads, sub-heads, leading, over-running, numbering, tabular forms, multiple justification; use of rules, borders, cutting and mitring machines; indentions, side notes, cut-in notes and concluding pages.
- NOTE:—It is intended that “book composition” or some similar project should incorporate all the operations referred to in the course.
6. The press: brief history, general types, principles of operation, proper care, and general experience in the safe operation of a platen press.

SHEET METAL

1. Materials:
- (a) The common properties, uses, limitations, methods of manufacture, approximate unit cost and stock sizes of the common sheet metals, such as black iron, steel, galvanized iron, tin plate, zinc and copper; reference to be made to the action of acids on these metals.
 - (b) Fluxes: types, special uses, preparation of fluxes for the metals listed in (a).
2. Hand Operations and Tools:
- (a) Laying out: transferring dimensions from a blueprint or drawing to the sheet metal in preparation for cutting; use of indentations for locating bending lines on reverse side of material; adding seaming allowance for double seams.
 - (b) Cutting: use of straight and curved snips; shearing with chisel and vise.

- (c) Folding and forming: use of bench stakes and tools such as hollow mandrel, blowhorn, conductor or improvised stakes in forming cylindrical and conical-shaped objects.
- (d) Riveting: use of rivet sets and punches; weights and sizes of rivets, spacing and punching rivet holes; blind riveting, forming rivet heads.
- (e) Soldering: selection of soldering iron, selection of proper fluxes; study of melting points of various solder alloys; proper application of solder to various types of seams.
- (f) Double seaming: metal allowance required, preparatory folds, proper stakes, method of turning seam with mallet, drawing metal back from folds, squaring and tightening seams.
- (g) Copper work: beating, annealing, pickling, polishing, lacquering or waxing, soldering, tinning and sweating.

3. Machine Tools and Operations:

- (a) Names of main parts, proper use, adjustments, and precautions to be observed for the foot squaring shears, bending brake, adjustable bar folder, slip roll former, and the wiring, burring and turning machine.
- (b) Operations: folding, locking, wiring, turning and burring of flat and cylindrical work.

CABINET-MAKING

1. Materials:

Lumber: pine, birch, maple, bass, gum, and walnut; three methods of curing (drying) namely, open-air drying, hot-air kiln drying, hot-air steam-jet drying.

2. Hand Tool Operations:

- (a) Sanding flat surfaces and moulded edges: use of flat sanding block (cork face).
- (b) Repairing damaged stock in the white wood.
- (c) Use of block, rabbet and router planes.
- (d) Assembling case goods.
- (e) Filling nail holes: preparation and use of fillers such as glue and sawdust, bees'-wax and sawdust, shellac and silex, stick shellac.

3. Machine Tools and Operations:

- (a) Cut-off saws: swing and straight-line sawing; cutting material to its rough length, use of stop blocks; setting up the machine.
- (b) Variety saw: operation and adjustment; ripping to width; tenon sawing; cross-cutting; sawing rebates; taper sawing; types of teeth for ripping and cross-cutting.
- (c) Jointer: operation and adjustment; buzz planing (surfacing), edge jointing; glue jointing of matched stock.

- (d) Planer: planing stock to finished thickness; planing thin stock; taper planing.
- (e) Band saw: adjustment of saw, tracking and tension; laying out work to avoid waste and for economy of sawing; use of jigs; folding the saw.
- (f) Mortiser: hollow chisel mortising, blind and through mortising; use of horns where mortise comes near end of stock.
- (g) Lathe: spindle, face and chuck turning; turning to a template; sanding turned work; special set-ups.
- (h) Grinder: grinding edge tools.
- (i) Boring machine: vertical and horizontal boring.

4. Upholstering:

Hard-seat covering: use of tow stuffing, muslin covering, leatherette covering; gimping and tacking.

5. Finishing:

- (a) Water and oil stains.
- (b) Mixing filler for a natural finish; use of silex, boiled oil, Japan drier, turpentine.
- (c) Shellacking, varnishing, water and oil rubbing; spiriting off.

CARPENTRY

The trade of carpentry is divided into three divisions: bench work, construction, and interior trim. Much of the work for this grade should be of the bench type.

1. Materials:

Lumber—classification as to rough work (concrete forms); exterior work such as studding, rafters; outside trim and interior trim such as casing, base-boards. Cost of material.

2. Hand Tool and Bench Work:

- (a) Rabbetting: planing a rabbet, using rabbet plane and guide strips.
- (b) Mortising: cutting a hand mortise (using mortise chisel) and tenon.
- (c) Hand dadoing: cutting dado across grain using guide strips, tenon saw and router plane.
- (d) Beading: cutting a bead by use of beading plane.
- (e) Hand mitring: mitring frame with rabbetted inside edge.
- (f) Sawing: cross and rip sawing; use of compass saw in cutting circular work.
- (g) Framing: the framing square; use of brace measure table, Essex board measure; laying out a common rafter; roof terminology, roof pitches.
- (h) Fitting butt, tee, strap and surface hinges, hasps and catches.

3. Machine Operations:

- (a) Variety saw: ripping, cross-cutting, grooving, dadoing, rabbetting; jigs for angle sawing.
- (b) Hollow chisel mortiser: set up and adjustment; mortising.
- (c) Boring: use of various types of boring bits; setting up and adjusting.
- (d) Band saw: operation and adjustment; resawing.
- (e) Sanders: operation and adjustment of drum and belt sanders.

PATTERN-MAKING

The pattern equipment to include materials and supplies for moulding, core making and pouring of soft metals.

1. Study of materials:

- (a) Pattern lumber: characteristics, identification, workability, warp, wind, shrinkage, shake and wind check.
- (b) Fasteners:
 - (1) Glue: kinds and preparation.
 - (2) Screws: types, sizes and specifications.
 - (3) Nails and brads: specification and application.
- (c) Fillets: available kinds, application and sources.
- (d) Colours and protective materials; classification of colours, pigments; shellac and its qualities.
- (e) Abrasives: types, grades, classification, manufacture and application.

2. Planning:

- (a) Interpretation of drawings, bill of materials, order of operation, sketching and full-size layout.
- (b) Machine allowance; signs and normal pattern allowances.
- (c) Draft; normal allowances on general pattern constructions, its application to simple patterns.
- (d) Contraction allowances; purpose of the allowance, introduction of the shrink rule allowances for cast iron and steel.
- (e) Simple core print forms; standard forms and dimensions.

3. Hand Tools:

Pattern-making hand tools for cutting, measuring, fastening, and assembling; use and care of tools; tool technique and sharpening.

4. Machine Tools:

- (a) Safety precautions, care and proper operation of machine tools.
- (b) Variety saw: ripping, cross-cutting, rabbetting tenon forms; use of ripping and cross-cutting saw blades.
- (c) Jointer: surfacing, edge jointing, glue jointing, taper planing.
- (d) Band saw: adjustment of machine and blades, layout for economical band sawing.

- (e) Grinder: grinding edge tools; tool angles for planing, cutting, and turning tools.
- (f) Wood grinder: grinding concave and convex surfaces, use of disc and spindle grinders, angular grinding for tapers and draft.
- (g) Jig saw: simple forms of cuts for scrolls and joints.
- (h) Lathe: turning between centres, simple face-plate work; preparing materials, setting up work; scraping and cutting tools; use of screw chuck.

5. Types of Constructions:

- (a) Solid and simple built patterns for bench including green and dry sand cores, vertical dry sand cores, attached core prints.
- (b) Turned solid patterns between centres, patterns with core prints for vertical and simple horizontal prints, simple split patterns for the lathe.
- (c) Combination of simple lathe and bench work with and without cores.
- (d) Forming simple type core boxes, square and round; testing; parted core boxes, use of dowel pins, core box proportions.

6. Foundry:

- (a) Moulding: simple moulding equipment; making two-part mould; procedure in making, ramming, simple venting, pattern removal, finishing, runners and gates, closing; green sand cores formed by pattern; use of simple type cored moulds.
- (b) Casting: preparation of metal, safety precautions, pouring; checking casting.

FARM MECHANICS

1. Drawing and Plan Reading:

Map drawings showing buildings, roads, fences, gates, streams, bridges, culverts, water-lines, tanks, drain tiles, soil areas, drainage direction, existing crops and orchards; working and assembly drawings; drawings of farm objects to include sections and scales.

2. Woodwork:

- (a) Tool sharpening: use of grindstone, emery wheel and oil-stone in sharpening common hand tools; practice in jointing, setting and filing hand saws.
- (b) Construction and repair: construction of two or more articles of use in the shop, in the home or about the farm, such as farm shop tool cabinet, nail and staple box, mitre box, folding bench, step-ladder, book-case, farm gate, poultry feed box, oat sprouter, or fattening crate.

3. Painting and Finishing:

Materials used in paints, shellac, and varnish, and meaning of terms, pigment, vehicle, thinner, drier; mixing paints and painting for specified conditions of exposure; methods of refinishing floors and furniture; whitewashes for farm use.

4. Forging and Metal Work:

- (a) Forging such articles as meat hook, rope cleat, chain link, cold chisel, and door-pull, to give a knowledge of forging and tempering; use of hack saw in cutting metal; use of the cold chisel and file in vise work with cold metal.
- (b) Soldering: preparation of soldering iron, selection of fluxes; soldering applied to needs of home and farm.
- (c) Drilling: use of post drill for drilling and countersinking; use of taps and dies.

5. Rope work: an extension of Grade IX work.

6. Farm Machinery:

- (a) Implements: types, uses, care and repair.
- (b) Motor mechanics: dismantle and assemble a four-stroke cycle and two-stroke cycle engine to learn the location, names and functions of the principal parts and events in the cycle; study automobile parts for an elementary knowledge of the clutch, brakes, transmission and electrical system; perform service jobs such as patching tubes, changing tires, lubricating and making up anti-freeze solutions.

COURSES OF STUDY

GRADE XI

Pupils enrolled in Grade XI are required to elect a particular shop in which to specialize if such choice has not been previously made.

Instruction in this elected shop is supplemented by instruction in a number of related shops, one of which must be drafting.

The time devoted to shop work may be distributed among the major and related shops according to the varying demands of industry for highly specialized workmen and the capacity of the school organization to meet the needs of the particular enrolment.

MACHINE DRAWING

1. Machine Parts:

Detail and assembly drawings of machine parts or mechanical equipment such as pulley transmission, tight and loose pulleys, safety collars, shafts and bearings, belt-shifting mechanisms, simple clutches.

- (a) Instruction regarding machining operations, tolerances, choice and purpose of materials used, pattern-making and moulding practice, shop terms.
- (b) Machine fastenings: selection of and correct specifications for machine screws, stud bolts, nuts, washers, taper pins, cotter pins, keys and keyseats, woodruff, feather and taper keys; national coarse and national fine threads; acme and square threads; right and left hand threads.
- (c) Machine fits: running, push, wring, press, shrink.
- (d) Quarter, half and revolved sections; broken views; auxiliary views.
- (e) Drawing of machine parts from notes and sketches prepared from measurements of actual objects; use of measuring instruments.
- (f) Inking, tracing and blueprinting.

2. Structural Steel:

- (a) Standard structural shapes—introduction to the structural steel handbook.
- (b) Lap and butt joints, types of rivets, bolts and welds.
- (c) Simple structural steel detail drawings, rivet symbols, pitch of rivets, dimensioning, gusset plates, base plates.
- (d) Bill of materials, calculation of lengths for rivets and bolts; preparation of rivet and bolt lists for shop and field work; paints and surface protection for structural steel.

3. Engineering Curves:

Drafting projects using such examples as parts of steam engine or internal combustion engine.

- (a) Practical geometrical layout for such curves as the ellipse, helix, and involute.

- (b) Plotting of curves for cams, uniform motion, harmonic motion, variable motion, quick return motion.
- (c) Applications of levers, cranks and cams in changing direction of motions; reversing mechanisms.

4. Development of Surfaces:

- (a) Triangulation method of development for objects such as transition pieces and irregular conical shapes.

5. Gearing:

- (a) Spur gears: tooth parts; plotting tooth curves by Odontograph tables and arcs of circles; drafting problems involving detail of pinion and spur gear; speed changing.
- (b) Bevel gears: right angle, acute angle and obtuse angle, top and bottom angles, pitch diameter; project of two gears in mesh to include tooth profile.
- (c) Worm and worm wheel: layout of worm threads, calculations for pitch and outside diameter, purpose of single, double and triple threads; drawing of worm and worm wheel.
- (d) Gear trains: spur, bevel, worm-gear trains; racks and pinions, speed-changing problems; calculation of the horsepower transmitted by spur and bevel gears using the Lewis formula.

6. Jigs and Fixtures:

A study of the uses of jigs and fixtures for performing machine operations; layout of a simple jig such as a drilling jig; applications of shop mathematics in determining angles, offsets and dimensioning.

ARCHITECTURE AND BUILDING CONSTRUCTION

1. Building Construction Details:

- (a) Preparation of working details, involving the following elements singly or in combination:
 - (1) Foundations: slab, stepped, offset, plain and reinforced footings; post, pier, column, and wall foundations; foundation waterproofing.
 - (2) Frame wall construction: elements of balloon and braced frames; wood and masonry veneer coverings.
 - (3) Masonry wall construction: wall thicknesses; face and backing units; arch types and their geometrical layout.
 - (4) Wood floor construction: joist arrangement, fire-stops, bridging, girders, trimming, floors.
 - (5) Carpentry and joinery: joints, rough and finished carpentry, trim details.
 - (6) Windows: double-hung, casements in wood and metal; mullions, caulking; types for wood and masonry walls.
 - (7) Doors: construction, exterior and interior types and sizes, hardware.

- (8) Fireplaces: hearth, throat, and flue construction; surround and mantel.
 - (9) Chimneys: flue types and sizes; wall sizes and materials; cleanouts.
 - (10) Stairs: types; open and closed-string construction; tread, riser, and hand-rail relation.
 - (11) Wood roof framing: elements of the flat, lean-to, hip, gable, gambrel, mansard types; dormers, coverings, cornices.
 - (12) Flashings: for hips, valleys, chimneys, cornices, parapets, soil pipes.
- (b) Layouts and working drawings: incorporation of the foregoing details in the working drawings for a kitchen equipment layout, summer cottage, or similar project.

2. Building Materials and Methods:

An elementary study of the materials of building construction and the local building by-laws and practices. This study to be carried on concurrently with the preparation of the details outlined in 1, above.

- (1) Wood: drying, shrinkage, defects, sawing, grading, measurement; properties and uses of various building woods.
- (2) Lime: properties; crushed and hydrated; mortar, plaster.
- (3) Portland cement: properties, uses in mortar, stucco, concrete.
- (4) Brick: varieties, uses, bonding types, joints, mortar.
- (5) Stone: classifications, properties and uses of granite, limestone, sandstone, marble, slate, shale; rubble, ashlar, veneers, bonding, waterproofing.
- (6) Concrete: proportions, mixing, placing, curing, forms, uses.
- (7) Gypsum products: properties of gypsum; use in plasters, boards, blocks, slabs.
- (8) Masonry units: concrete, cinder-concrete, silica, clay blocks.
- (9) Flooring: wood, concrete, terrazzo, mastic, tile, linoleum, cork, rubber coverings.
- (10) Glass: varieties, commercial standards, structural glass and block.
- (11) Paint: composition and uses of paints, enamels, varnishes, stains; paints for wood, metal, plaster, concrete.
- (12) Metals: properties and uses of iron, steel, copper, lead, zinc, tin.

3. Structural Design:

- (a) Elementary treatment of stresses in structures; tension, compression, shear, unit stress.

- (b) Bending moments and shear stress for uniformly distributed, concentrated, and cantilever loads; construction of bending moment and shear diagrams for the above.
- (c) Calculation of wood joist sizes for ordinary uniformly distributed loads; determination of maximum spans for commercial size joists in deflection; pier and footing sizes.

4. Perspective and Rendering:

- (a) General principles of perspective projection; determination of station point, picture plane, horizon, lines of heights, and vanishing points.
- (b) Problems in angular and parallel perspective applied to architectural details involving rectangular, triangular and pyramidal solids, curved lines and cylinders.
- (c) Rendering in pencil of simple forms in light and shade; rendering of simple architectural instrumental perspective in pencil.

5. History of Architecture and Design:

- (a) General outline of the history of ancient building, with emphasis on the Greek and Roman periods, particular attention to be given to the use of materials, methods of construction and to the form and proportion of details of these periods which are still in use.
- (b) Freehand sketches or formal drawings of representative details of the various periods.

APPLIED ELECTRICITY

A. INSTALLATION AND MAINTENANCE

1. Circuits:

- (a) The installation and study of more advanced work in electric services; non-metallic, metallic and rigid conduit circuits for light, heat and power.
- (b) Installation of D.C. and fractional A.C. motors using different types of starters and protective devices commonly used in industry.

2. Testing and Repair:

- (a) Testing and repair of circuits used in light, heat, and power, including D.C. motors, generators and industrial control equipment.
- (b) Stripping, securing winding data and rewinding one D.C. armature; making all necessary tests before, during, and after rewinding; truing-up commutator, undercutting mica, and complete final check-up before assembling for running test.

B. THEORY AND TEST

1. Electro-magnetism:

- (a) Application of Ohm's Law to the magnetic circuit to determine the relations between magnetomotive force, flux density and reluctance.
- (b) Development of magnetic circuit equations and plotting of magnetizing curves for cast iron, wrought iron and steel.

2. Insulation:

Properties of insulating materials such as rubber varnishes, plastic compounds, impregnated paper, varnished cloth, tapes, asbestos and silk.

3. Resistors and Resistance Measurements:

- (a) An examination and study of resistors used in industrial control apparatus for controlling motors and generators.
- (b) Measurement of resistances connected in series or combinations of both; methods of determining the combined resistance.

4. Induced Currents:

- (a) The production of induced currents including the elementary laws of induction relating to direction of induced pressure.
- (b) Development of E.M.F. equation for D.C. generators and motors.
- (c) Building up D.C. generator voltage.
- (d) Motor speed as related to field strength.

5. D.C. Generators:

Operation and control of D.C. shunt, series and compound-wound generators to determine their characteristics.

6. D.C. Motors:

Operation and control of D.C. shunt, series and compound-wound motors to determine their characteristics.

7. Maintenance:

Tests used by journeymen in locating troubles in D.C. motors, generators and industrial control apparatus; methods of repair.

8. Determination of efficiency characteristics of D.C. generators and motors based on actual laboratory tests.

MACHINE SHOP PRACTICE

1. Hand Tools and Bench Work:

- (a) Chipping: cast iron and steel, various chisels and their uses.
- (b) Filing and scraping: a flat surface; irregular forms requiring a variety of shapes and cuts of files.
- (c) Reaming: parallel and taper holes.

2. Layout Work:

Use of precision measuring instruments such as protractor, thread and micrometer gauges, surface plate and surface gauge.

3. Machine Operations:

- (a) Lathe: shifting a centre, truing a damaged centre, aligning centres; freehand turning; cutting right and left hand national standard threads, and square threads; face-plate work, independent chuck work; taper turning and fitting to gauges; setting a gear-change lathe; steady and follow rest applications.

- (b) Drill press: clamping of irregularly shaped work and practice in drilling and countersinking in various metals; counterboring; reaming; use of drilling jigs; boring bar and flycutter.
- (c) Shaper: dovetail cutting, internal and external; machining of irregular surfaces; internal keyseating.
- (d) Miller: setting up and care and operation of machine; methods of setting up and securing work; plain and side milling; sawing and slitting; use of form cutters and flycutters; direct and plain indexing and plain milling of squares and hexagons.
- (e) Grinder:
 - (1) Practice in grinding tools and drills of various forms and sizes.
 - (2) Surface grinder: securing work, adjusting feed and stroke, dressing wheel; surface grinding.
 - (3) Portable grinder: grinding lathe centres; external grinding in the lathe.

4. Metallurgical Work:

Ferrous and non-ferrous metals in common use, alloys of same; theory of and practice in hardening, tempering and annealing; classification of metals, spark test; hardness test (file).

5. Materials and Calculations:

A study of trade-names, processes, stock materials and sizes, approximate costs and markets; applications of mathematical principles such as gear ratio, feeds and speeds, and tapers and index calculations.

6. Welding and Brazing:

Oxy-acetylene method: the torch, lighting the torch; neutral, reducing and carburizing flames; manipulation of torch for welding and brazing; fluxes; testing joints.

MOTOR MECHANICS

To introduce trade work in the Grade XI course automobiles to be admitted to provide for such work and operations as fall within the scope of this course.

1. Engine:

- (a) General construction of typical multi-cylinder engine; cylinder and valve arrangements; types and materials of crankshaft, main bearings, pistons, piston pins, connecting-rods, valves; valve action details; valve timing.
- (b) Engine lubrication; theory of lubrication; engine oil specifications; details of typical engine lubricating system.
- (c) Engine power; factors of power; calculating engine horsepower; piston displacement; compression ratio; relative pressure.
- (d) Common causes of abnormal engine noises.

2. Engine Service Operations, such as:

- (a) Checking engine cylinder compression.
- (b) Measuring cylinder wear.
- (c) Fitting connecting-rod bearings, piston pins, piston rings, checking connecting-rod alignment.
- (d) Reconditioning engine valves, valve seats; adjusting valve clearances.
- (e) Replacing water-hose connections.

3. Automotive Electrical Systems:

- (a) General outline of the various systems involved: starter, generator, lighting, and ignition; types, kinds and sizes of automotive electrical wires, cables and terminals.
- (b) Storage battery: general construction and operation of automotive type; testing and charging storage battery.
- (c) Starter system: location in circuit and purpose of units involved; general construction and operation of typical starter motor.
- (d) Generator system: location in circuit and purpose of units involved; general construction and operation of typical automobile generator.
- (e) Lighting system: purpose and location of various units involved; types and kinds of automotive lamp bulbs; adjusting headlamps; connecting electrical accessories; purpose and location of fuses.
- (f) Ignition system: purpose and location of various units involved in typical automobile ignition system; construction and types of spark plugs, cleaning and adjusting spark plugs; adjusting and setting ignition timing; installing and connecting distributor wires.

4. Fuel System and Carburetion:

- (a) Kinds of gasoline: high test, low test, high compression; octane rating.
- (b) Construction and operation of typical mechanical fuel pump.
- (c) Further study of principles and requirements of carburetor and simple adjustment.
- (d) Carburetor types and styles.
- (e) Cleaning fuel strainer and air cleaner.

5. Transmission Systems:

- (a) Various units involved and relationship to one another.
- (b) Clutch construction: dismantling, identifying and replacing defective parts, assembling and adjusting.
- (c) Gear-box construction and general principles of synchronized gear engagements: dismantling, identifying and replacing defective parts, assembling and adjusting.
- (d) Rear axle arrangements; types and applications; construction of typical rear axle unit; hypoid gears.

6. Steering Gear, Road Wheels and Brakes:

- (a) Types of front-wheel mountings; solid axle and independent wheel suspension.

- (b) Meaning and purpose of camber, caster, king-pin inclination, toe-in; making minor adjustments to wheel alignment.
- (c) Construction of two popular types of steering gear; adjusting steering gear and linkage.
- (d) Type of brakes; mechanical and hydraulic operation; general principle of hydraulic brake system; construction of two popular types of brake units; removing, replacing and adjusting typical brake-shoe assembly.

PRINTING

1. Study of Materials:

- (a) Type faces: classification into basic groups—text, Roman, Italic, Gothic or sans serif, script or cursive; a comparative study of available faces in shop, identifying characteristics.
- (b) Roman sub-divided into old style, modern, transitional, antique.
- (c) Type sizes: application of point system, fontage, alignment, shoulder depth.
- (d) Type series: analysis of possibilities for variety without mixing; small caps and italics.
- (e) Type families: development from original face—bolder, lighter, condensed, extended; unity with variety, effects of development on beauty and legibility.
- (f) Letter-spacing: examination of typical faces for proper letter-spacing.
- (g) Rules, borders, ornaments: brass, machine, foundry; trade practices as to body sizes, fontage, purpose, use, dangers.
- (h) Paper: history, sources of materials, processes, kinds, uses.
- (i) Inks: kinds, materials, manufacture; fitness for use as to paper, press.
- (j) Engravings: line, Ben Day, halftone, wood, wax, and lino.
- (k) Plates: electro, stereo and rubber.

2. Planning a Job:

A thorough study of the steps in planning any piece of job-printing or advertising—analysis of copy, choosing important or salient points, making sketches and making a complete layout.

3. Job Composition:

A number of jobs to be developed as above, set, proofed, read, corrected, and proofed again. These jobs to consist of many types of business forms and advertising including school printing. Jobs designed and planned in the related art classes to be completed in the print shop wherever possible.

4. Press Work:

- (a) The platen press:
 - (1) Feeding: placing stock, fanning out, picking up, placing, removing; cleanliness, safety; causes of faulty work; slip-sheeting.

- (2) Care of press: oiling, inking, operating, setting up, cleaning up.
- (3) Lock-up: materials, uses, positions, procedure.
- (4) Putting job on press: reading order, preparing press, putting form on, precautions, make-ready, checking, O.K.
- (b) Progressive acquaintance with, and experience on any other types of press available.

NOTE:—In schools where there is a fully equipped pressman in charge, a more comprehensive course in press-work is advisable.

SHEET METAL

1. Pattern Development:

- (a) Parallel line development: two and three-piece round and rectangular elbows; ordinary tees and Y-branches; simple eavestrough and coping mitres; scoops, scalepans and register boxes.
- (b) Radial line development: conical-shaped articles such as funnels, flaring pans, pitched covers and tapering pails or measures.
- (c) Triangulation method of development: irregular shapes such as rectangular flaring pans; simple transition fittings such as square to rounds or ovals.

NOTE:—All patterns developed to be fabricated in metal to actual size.

2. Seams and Seaming Allowances:

Various types and uses of such seams as standing, double, grooved, Pittsburgh, riveted and lined; the amount of metal required to make each seam; common uses and advantages of each in fabrication and installation.

3. Hand Tool Operations:

- (a) Soldering: forging soldering irons to shapes for various uses; soldering metals such as stainless steel, copper, zinc and lead.
- (b) Tinner's snips: use of various types such as straight, curved, double-cutting and scroll snips; care and sharpening of cutting blades.

4. Machine Operations:

- (a) Adjustable bar folder: adjusting folder for tension on various gauges of metals; width and types of folds.
- (b) Bending brake: adjusting for tension and bending on various gauges of metals; using forming attachments for making coves and ogees.
- (c) Roll former: adjusting and operating in forming cylindrical, flared and wired objects.
- (d) Burring machine: burring flat discs and cylindrical shapes for seaming.
- (e) Turning: turning edges of cylindrical and conical-shaped objects for wiring.

- (f) Wiring machine: wiring straight and formed edges.
- (g) Beading and crimping: for ornamenting, reinforcing and reducing cylindrical and conical-shaped objects.

CABINET-MAKING

The Grade X course to be extended to include cabinet fitting and assembling and more advanced work on the machines and wood finishing.

1. Materials:

- (a) Glues: casein and vegetable.
- (b) Upholstery webbing, burlap, tow, moss sateen.

2. Hand Tool Operations:

- (a) The adaptation of various joints to particular types of work; the use and sharpening of hand cabinet scrapers and the scraper plane; setting, jointing and filing saws (hand and machine); forms for clamping irregularly shaped stock; final cleaning up of assembled stock before applying finish.
- (b) Bill of material: taken from simple furniture drawings.

3. Machine Tools and Operations:

- (a) Cut-off saw: construction of machine, function of parts.
- (b) Variety saw: construction; use of jigs, set up for cutting a stop groove or dado.
- (c) Jointer: adjustment of tables; cutting tapers; use of stops or jigs.
- (d) Shaper: set up; shaping against the collar; use of fulcrum pin; use of yoke (straight board) guide; adjustment of hold down and guards.
- (e) Band saw: adjustment; sharpening.
- (f) Grinder: selection and care (dressing); grinding wheels.
- (g) Sander: construction and use of discs, drums and belts.
- (h) Safety precautions: great care to be exercised in stressing the use of proper speeds and feeds, and adjustment of guards; special guards to be used wherever necessary.

4. Upholstery:

Slip-seat construction; use of webbing; webbing stretcher, tow or moss regulator.

5. Finishing:

- (a) Sponging work: preparation and application of water, acid, oil and spirit stains.
- (b) Use of pumice and rotten stone in water and oil rubbing; rubbing with brilliantine (combination of pumice and rotten stone in oil).
- (c) Application of polish and spiriting off.

CARPENTRY

Where feasible a small structure or sections of structure should be erected to include the structural members suggested in the course. Reading and interpreting plans and specifications and taking off quantities of materials to be emphasized.

1. Bench Work:

- (a) The pupil to be instructed in the use of such hand tools as the stair-maker's dado saw, router plane, level, draw knife, straight-edge and chalk-line. Construction of a small-scale model of a simple straight open stringer and of a straight closed stringer stair.
- (b) Framing square: laying out of common, hip and valley rafters; allowance for ridge board.

2. Constructions:

- (a) Foundations: excavating, wall and footing forms; setting forms in position, separating to obtain wall thickness; basement drainage, basement windows and doors; supporting piers; levelling basement floor.
- (b) Flooring: setting and levelling sill plates, built-up girders, joists, headers; bridging, stair openings (wells), sub-flooring (straight and diagonal laying).
- (c) Frames: floor plate, studding, top plate, partition plates and studding, door and window openings; outside and inside sheathing; types and methods of laying commercial insulation; furring, wood and metal lath; the purpose and method of laying building paper on outside wall.
- (d) Siding: cove (novelty, drop), bevel (clap-board), tongue and groove, V-match, composition (asphalt) siding.
- (e) Trim: door and window frames; cornice trim; soffit, fascia, frieze, bed mould.
- (f) Roofing: gable and hip type; roof sheathing; setting purlins and collar ties.

PATTERN-MAKING

1. Study of Materials:

- (a) Pattern lumber: selection, defects, seasoning, grading disposition for strength and resistance to atmospheric changes.
- (b) Special pattern requisites: rapping plates, metal dowels, pattern letters, drawing straps, lifting screws.

2. Planning:

- (a) Preparation of orders of procedure, sketching and full-size pattern layout including cores and machine allowances.
- (b) Machine allowance, for ferrous and non-ferrous metals.
- (c) Principles of contraction and shrinkage in castings, making and design of shrink rules.

- (d) Pattern draft; determination of draft allowances in relation to the casting design; draft as it effects the machining of castings.

3. Hand Tools:

Extension of tool technique; use of higher precision measuring and checking tools such as core box planes, bent shank chisels and gouges, surface gauges, depth gauges.

4. Machine Tools:

Safety rules; lubrication, sharpening, setting and adjusting cutters and blades; use of jigs and holding devices.

5. Types of Constructions:

- (a) Patterns with horizontal cores, core print allowances for clearance and overhanging anchorage, attaching core prints.
- (b) Use of tail prints and core boxes.
- (c) Parted patterns for bench and lathe; use of dogs, fasteners and plates; combination of bench and lathe constructions; using core prints to strengthen constructions; proportioning core boxes.
- (d) Simpler type frame and box constructions in pattern and core boxes.
- (e) Introducing loose piece features in pattern and core box design; attaching with loose dowels and joints.
- (f) Face-plate turning, use of supplementary face-plates, attaching devices, toolcuts and positions; design and use of templates; application and layout of turned interior forms; measuring devices, rechucking, cutting speeds.
- (g) Use of cup chucks and screw chucks in turning shell patterns.

6. Foundry:

- (a) Moulding flasks, snap flasks, three-part flasks; use of cheeks and bars in flasks.
- (b) Types and positions of runners, risers, vents, gaggers and core irons.
- (c) Making three-part moulds, irregular partings, and cored moulds.
- (d) Core-making: sand and proportions, bonds; baking and inserting cores.

FARM MECHANICS

1. Drawing and Plan Reading:

- (a) Drawing to scale of rural maps and landscapes showing details.
- (b) Scale-drawing and blueprint reading of plans and elevations to include section and assembly drawings of various types of farm buildings; concrete form work.

2. Woodwork:

- (a) Tool sharpening: types of finishing stones and files for sharpening tools and implement cutters such as axes, hoes, cultivator points, binder and mower knives; jointing, setting and filing hand and circular saws.

(b) Construction and repair:

- (1) The work of Grade X extended to include more advanced woodwork used in framing construction such as a pinned mortise and tenon joint and a bolted spliced joint.
- (2) Simple frame construction involving the use of the framing square.

3. Painting and Finishing:

- (a) More advanced knowledge of grades of paints and their application to farm buildings and equipment.
- (b) The use of stains, fillers, shellac, varnish, pumice and rotten stone, rubbers and polishes; methods of refinishing floors and furniture.

4. Forge and Sheet Metal:

- (a) Bending, shaping, welding and tempering operations used in making typical farm articles such as a clevis, hook, hinge, link, and in pointing harrow teeth.
- (b) Constructing and repairing simple sheet-metal objects.

5. Farm Implements:

- (a) A knowledge of the construction and theory of operation of various types of farm machinery such as binders, pumps, windmills, and engines.
- (b) Value of proper housing.
- (c) Grades and proper use of lubricants.
- (d) Repairs such as replacing guards on cutter bars, sections in blades, adjusting binder knotters, replacing slats and straps on binder canvases.

6. Concrete Work:

- (a) Proportions and methods of mixing.
- (b) Construction of wood and metal forms.
- (c) Selecting, testing and mixing aggregates.

7. Pipe Work:

- (a) Cutting, threading, fitting and assembling pipe.
- (b) Installation and maintenance of valves and fittings.

8. Motor Mechanics:

Prepared units and models to be set up for practice operations. Typical service adjustments similar to those suggested here to be planned around the available equipment.

- (a) Engine: removing and replacing gaskets, pistons, connecting-rod assemblies; adjusting valves; examining cylinders, pistons, pins and rings for wear; a study of piston travel, compression and displacement.
- (b) Electrical system: operation, care and minor service jobs involving battery, generator, starter, ignition and lights.
- (c) Carburetion: principles of carburetion; simple service jobs involving cleaning and adjustment.

- (d) Transmission system: dismantling and assembling clutch, gear box, universal, front and rear axle, springs and wheels.
- (e) Steering and brakes: examination of a typical steering linkage and assembly; types of braking systems, mechanical and hydraulic; adjusting two types of brake shoes.
- (f) Traffic regulations: a study of important rules and regulations of the Ontario Traffic Act.

COURSES OF STUDY

GRADE XII

Pupils enrolled in Grade XII are expected to continue their courses on the specialization plan as set up for Grade XI.

MACHINE DRAWING

1. Machine Drawing and Design:

Design of small typical machines such as lathe, drill press, punch press, scroll saw, grinder, shaper.

- (a) Gathering data from catalogues, hand-books and reference books.
- (b) Calculations of speeds and feeds, and sizes of gears and pulleys; selection of materials; discussion of pattern-making problems and moulding practice; methods of lubrication.
- (c) Shafts and couplings: flange couplings, shaft collars, fluted and splined shafts, universal joints, flexible couplings.
- (d) Bearings: babbitt, bronze, roller, ball.
- (e) Sketching machine parts to determine approximate dimensions; making layout in pencil.
- (f) Detail and assembly drawing, checking, tracing in ink, blueprinting.
- (g) Preparing weight sheets, cost sheets and material shop orders.

2. Gearing Problems:

- (a) More advanced problems in spur and bevel gears; racks and pinions; spiral gears.
- (b) Drafting problems in the layout of such devices as planer reversing mechanism, pawl and click type ratchets, chain gear or sprockets, gear chains.
- (c) Transmission problems involving gears, shafts and bearings such as a geared winch or other geared drives or mechanisms.

3. Dies and Die Design:

- (a) Types of dies: blanking, punching, bending, bulging, drawing, follow, shearing, forming.
- (b) Parts of a die set: die shoe, die, stripper plate, guide pins, dowel pins, punch, punch holder, shank, guide-pin bushings, stops; die set materials.
- (c) Layout and drawings for a punching and blanking die set complete with specifications for materials.

4. Structural Steel Drawing:

- (a) Graphical solutions for stress diagrams of simple frames such as derrick frames, Pratt and Fink trusses.
- (b) Design of a simple Fink truss complete with calculations for members; use of the structural steel hand-book; the selection of standard shapes; efficiency of riveted joints; applications of mathematics for calculating bevels and accurate layout.
- (c) Bill of materials and weight sheets; use of letter indications and match marks for assembly; erection diagrams.

5. Sheet Metal Pattern-drafting:

Problems combining several methods of development of surfaces; triangulation and radial line method applied to such projects as the layout of ventilators, tapered funnel top, measuring can, layout of cornice and cornice mitres, sheet-metal caps and finials; the development of the sphere and hemisphere using the gore and zone methods.

6. Strength of Materials:

(a) Design problems involving elements of strength of materials: simple tension, compression, bearing, direct shear and bending or deflection; unit stress, ultimate stress, elastic limit, safe working stress, factors of safety; use of hand-books to determine physical properties of materials.

(b) Design of some simple machine such as a hoisting block for a crane.

7. Drafting Office Routine:

Drafting office organization: filing and routing systems, division of staff duties and responsibilities.

ARCHITECTURE AND BUILDING CONSTRUCTION

1. Working Drawings:

(a) Residence plans: preparation of working drawings of a small residence at $\frac{1}{4}"$ scale, complete with details, such as wall sections, windows, main entrance doorway, porches, cornice, bay windows, dormers, kitchen cupboards, staircase, mantel, and interior trim. Drawings to be traced in ink.

(b) Mechanical equipment layouts: piping diagrams for hot-water heating and water-supply systems; duct layout for the heating and ventilating of a small building.

(c) Structural steel details: working details using standard shapes for steel-framed floor bay, or similar project.

(d) Surveys: drawing of land plot from notes prepared in field, showing buildings, natural features, levels, linear and angular measurements; measurement of building details.

2. Building Methods and Materials:

The work of Grade XI extended to include:

(a) Running lines and staking out.

(b) Organization of work and sequence of trades.

(c) Study of plumbing installations including materials and construction of drains, soils, wastes, vents, traps, fixtures, septic tanks, hot and cold water supply, gas piping.

(d) Heating installations; comparison of warm air, hot water, and steam systems; gravity and forced circulation; boilers, radiators, pipe and fittings, controls; elements of air-conditioning; fuels; calculations for heat loss, radiation, duct work; insulation—types, points of application.

- (e) Electrical work: service entry, switches, distribution, circuit arrangements; armoured cable, non-metallic cable and rigid conduit installations.
- (f) Study and preparation of specifications for a small residence covering excavation, masonry, rough and finished carpentry, lathing and plastering, sheet metal and roofing, tile and marble work, painting and glazing, plumbing, heating, and electrical work.

3. Estimating:

- (a) Approximate methods of estimating building construction by the cubic foot and square foot.
- (b) Consideration of the units of measurement, methods of estimating and pricing for: general items, excavation, grading, brickwork, mortar, rough and dressed stonework, concrete, concrete block, waterproofing, rough wood framing, sheathing, siding, shingles, frames and sash, exterior and interior doors, finished carpentry, trim, and fittings, wood flooring, linoleum, sheet-metal work, built-up roofing, lathing, plastering, painting, glazing, marble, tilework, electric wiring, heating, plumbing, insulation.
- (c) Application of (b) above in taking off quantities for student's residence plans.

4. Structural Design:

- (a) Extension of Grade XI work to calculation from formulae of bending moment and section modulus for uniformly distributed, concentrated, cantilever, or combined loads.
- (b) Design of steel lintels, and beams in shear; lateral bending, and deflection; design of steel columns.
- (c) Use of hand-books in solution of structural problems.

5. Perspective and Rendering:

- (a) Extension of Grade XI work to include instrumental perspective of architectural subjects in angular or parallel perspective.
- (b) Use of conventional architectural shades and shadows.
- (c) Problems in rendering using pencil, pen and ink, monochrome, or full colour.

6. History of Architecture and Design:

- (a) Continuation of Grade XI work in the history of architecture, with emphasis on the mediaeval, renaissance, and modern periods. Materials and methods of construction to be stressed. Freehand or formal drawings of details.
- (b) Consideration of factors in design such as proportion, balance, unity, and scale as seen in historical examples, or objects of everyday use.
- (c) Influence of materials, utility, and methods of fabrication in architectural or industrial design.

APPLIED ELECTRICITY

A. INSTALLATION AND MAINTENANCE

1. Circuits:

- (a) Distribution systems in non-metallic, metallic and rigid conduit circuits for light, heat and power, such as might be used in modern apartment buildings and small factories.
- (b) Practical installation of A.C. motors using different types of starters and protective devices commonly used in industry.

2. Maintenance:

- (a) Locating troubles in generators, feeders, motors, and industrial control apparatus; methods of repair.
- (b) Insulation: specifications of the insulation of high-tension and low-tension conductors when installed in motors, starters, switchboards and distribution systems.
- (c) Rewinding: stripping, securing winding data and rewinding a single-phase and a three-phase induction motor; making all necessary tests before, during and after rewinding.

3. Specialized services, such as one or more of the following: signal systems, radio service and armature winding.

B. THEORY AND TEST

1. Elements of Alternating Current:

- (a) The development of the sine wave as obtained from actual test compared with the geometric construction of the wave.
- (b) Frequency, alternation, cycle and effective value of sine wave for voltage, current, power and flux.

2. Alternating Current Circuits:

- (a) Inductance, capacitance, reactance and impedance.
- (b) Application of Ohm's Law to alternating current circuits.
- (c) Current and voltage relations in A.C. series and parallel circuits.
- (d) Measurement of power and power factor including the meaning of the terms phase, phase angle, lagging and leading currents; actual measurement of power in non-inductive, inductive, and capacitance circuits to determine the relation between apparent, reactive and effective power; actual measurement of power in single, two and three-phase circuits.

3. Alternating Current Generators:

- (a) Construction of typical single and multiphase generators.
- (b) Principles of action for simple and multiphase distribution of windings; possible combinations of conductors to eliminate copper.
- (c) Parallel operation of generators involving synchronizing by use of lamps.

4. Alternating Current Motors:

- (a) Experimental study of the revolving magnetic field.
- (b) Comparison of starting characteristics produced by single and multiphase fields cutting a short-circuited armature winding.
- (c) The construction and commercial uses of three-phase squirrel-cage and wound-rotor induction motors, including an experimental study and calculation of transformer effect, slip, speed characteristics, starting current, full-load current, power factor, torque and efficiency characteristics.
- (d) The construction and commercial use of single-phase induction motors, including a study of special starting devices, construction and arrangement of windings, starting currents, torque, speed characteristics, power factor and efficiency.
- (e) The construction and commercial use of synchronous motors, including a study of starting methods, power factor and speed characteristics, power factor correction, and efficiency.

5. Calculation of wire sizes for various distribution systems.

6. Insulation:

- (a) Study of the characteristics and applications of different kinds of insulating materials used in industry for protection of low and high-tension conductors.
- (b) Specifications of insulation of coils, lead, terminals, splices, iron core, turns, coil coverings, including the protection and factors governing the design of coils.
- (c) Specifications of insulating varnishes and transformer oils for electrical apparatus.

7. Transformers:

- (a) Construction, principles of action, efficiency, load characteristics, and commercial uses.
- (b) Transformer connections, star, delta, "T" or Scott connection, open delta, for light, heat and power.

8. Instruments:

An elementary study of the theory of operation, uses and proper line connections of such instruments and meters used commercially to measure alternating current, voltage and power as ammeters, volt-meters, single and polyphase watt and watt-hour meters, maximum demand meters and synchrosopes.

MACHINE SHOP PRACTICE

1. Hand Tools and Bench Work:

- (a) Filing and scraping: production of true and parallel surfaces; machine slide fitting, production of curved surfaces, bearing fitting.
- (b) Lapping hand: suitable abrasives, preparation and application of abrasives; testing surfaces.

- (c) Bearing lining: suitable materials; tinning and anchoring metals; preparation of arbor and collars; sealing and venting; pouring and peining metals.
- (d) Chipping as required: as a corrective measure; in repair work.

2. Layout and Gauging:

More advanced layout work involving tool-makers' buttons and trigonometry; construction and use of dial and test indicators; use of depth and height gauges.

3. Machine Work:

(a) Lathe:

- (1) Eccentric turning, external and internal.
- (2) Thread cutting: (i) acme and buttress threads, (ii) cutting right and left-hand threads, external and internal, (iii) multiple threads, (iv) rechucking work with the indicator dial, (v) recentering work using the indicator.
- (3) Centre spacing on face-plate, using tool-makers' buttons.
- (4) Forming tools; use of backing off attachment.

(b) Shaper: study of Whitworth and oscillating link motions and application; advanced problems involving accuracy and special set-ups.

(c) Miller: making various tools, such as hobs; cutting spur gears, cutting bevel gears, cutting and hobbing a worm gear; spiral cutting, differential indexing; miscellaneous milling continued.

(d) Drill press: further work to develop accuracy and technique; setting up irregularly shaped work; clamping to avoid stresses; jigs and fixtures.

(e) Grinder: reamer grinding, straight and spiral flutes; form cutter grinding; drill grinding; internal grinding, cylindrical and tapered; internal grinding in lathe.

4. Metallurgical Work:

- (a) An elementary study of and experience in the use of the thermocouple and pyrometer.
- (b) Examination of sections with a view to determining the granular structure and its corresponding physical characteristics.
- (c) Further practice in annealing and case hardening.

5. Welding:

Oxy-acetylene welding or brazing as may be required for construction or repair work; cutting with the torch; flame hardening.

MOTOR MECHANICS

The work of Grade XII is to involve diagnosis and servicing of common mechanical and electrical troubles with emphasis on preventive and periodic service rather than breakdown and heavy repair work.

1. Engine:

- (a) Construction: a thorough study of a typical modern automobile engine; standards of accuracy and precision; service work to maintain original standards.
- (b) Identifying parts likely to require replacement; reconditioning or adjustment due to wear.
- (c) Diagnosing engine mechanical defects:
 - (1) Testing for loss of power through leaking valves, pistons and gaskets.
 - (2) Testing for loose or worn pistons, worn cylinders, piston pins and bearings.
 - (3) Locating causes of overheating.
 - (4) Locating causes of excessive oil consumption.
- (d) Reconditioning or replacing engine parts not covered in Grade XI, such as cylinders, pistons and bearings.

2. Automotive Electrical Practice:

- (a) Use and care of elementary automotive electrical test equipment; test lamp, voltmeter, ammeter; diagnosing electrical troubles, system of elimination.
- (b) Testing storage battery: state of charge and defects; common storage battery troubles; care of the storage battery.
- (c) Remote controlled starter system: popular types of starter drives; identification of circuits, locating faults in system; testing starter motor input current and output torque; dismantling and assembling starter motor, and testing internal windings.
- (d) Generator output control methods; third-brush regulation and voltage control; identification of circuits; locating faults in generator system; testing generator for output; dismantling and assembling generator, and testing internal windings; testing and adjusting voltage regulator.
- (e) Types of ignition systems in common use: two-arm timers; common ignition system troubles, proper procedure for diagnosing ignition troubles; testing spark plugs; ignition coil; condenser; spark control methods; checking automatic spark control for accuracy; replacing and adjusting timer contacts; setting ignition timing; synchronizing two-arm timers.
- (f) Types of headlamps commonly employed; sealed-beam units; replacing headlamp units; testing for poor headlamp illumination; headlamp glare; aiming headlamps to meet requirements of law; headlamp control methods; protective devices, fuses; current limit relays.

3. Fuel System:

- (a) Construction and operation of typical modern carburetor; double-throat carburetors, types and purposes.
- (b) Dismantling and assembling carburetor to discover parts commonly requiring replacement, reconditioning or adjustment; carburetor adjustments and settings.

4. Engine Tune-up Operations:

- (a) Determining engine mechanical conditions before proceeding with engine tune-up; use of compression gauge and vacuum gauge; testing compression; checking valve clearance; inspecting engine lubricant.
- (b) Operations in engine tune-up and importance of correct sequence: valve clearance; battery condition; generator voltage; ignition system units; fuel system units; carburetor adjustments; vacuum test.

5. Transmission System:

- (a) Common clutch troubles; reconditioning modern clutch; replacing clutch facings and bearings; aligning clutch; clutch adjustment.
- (b) Construction and operation of popular form of synchronized type gear box; troubles likely to be encountered; making minor adjustments.
- (c) Types of universal joints and their different service requirements.
- (d) Diagnosing for various rear axle troubles; gear mesh and gear lash required.
- (e) Removing, replacing and adjusting rear axle gears.
- (f) Gear lubricants for particular requirements.

6. Running Gear:

- (a) Types of front wheel suspension.
- (b) Common troubles of steering gear, causes and remedies; checking front wheel alignment; steering geometry; adjusting steering gear and linkage on modern independent wheel suspension.
- (c) Construction and operation of modern hydraulic brake system; common troubles of modern brake system; replacing brake cylinder rubber seals and bleeding brake fluid lines.
- (d) Removing, replacing and adjusting complete set of brake shoes and drums.

PRINTING

1. Display:

- (a) Definition and history:
 - (1) Analyzed and defined.
 - (2) Classified as to medium—newspaper, magazine, direct mail.
 - (3) Origin, purpose, development and growth.
- (b) Functions:
 - (1) To attract.
 - (2) To interpret.
 - (3) To induce action—modes, methods, devices.

(c) Essential elements:

- (1) Legibility: types, measures, breaks.
- (2) Simplicity: how achieved.
- (3) Unity or purity of style: type faces, grouping, arrangement, consistent treatment.

(d) Planning or designing:

- (1) Analysis: nature of job, nature of business or product, to whom addressed, probable reading conditions, effect of these factors on the design or treatment of the piece.
- (2) Analysis of copy: relative importance or value of parts, choice of dominant and secondary points for display.
- (3) Preliminary sketches: experimental pencil work, possible and alternative treatments in design, choice of most promising sketch.
- (4) Choosing type faces: factors involved—space, measures, illustrations, copy, medium.
- (5) Making the layout: details required—dimensions, margins, borders, rules, lettered lines, blocked masses, illustrations, positions, and specifications.

(e) Principles:

- (1) Harmony: shape and direction, type to paper, materials—type, illustrations, rules, borders, ornaments; tone—grays, blacks, faced, colours.
- (2) Contrast: black and white, large and small, different faces, grouping or use of white space, colour; danger of overemphasis or wrong emphasis.
- (3) Proportion: width to length, type area to paper area, margins, parts to whole and to each other, type size to page size; laws, ratios, factors.
- (4) Balance and symmetry: points of balance—optical centre, line of golden proportion; kinds of balance—formal, informal; symmetrical or conventional *vs.* modern layouts.

2. Illustrations:

- (a) Kinds: line, Ben Day, halftone, linoleum, rubber, wood.
- (b) Choice: for paper, job, conditions.
- (c) Placing: position, direction, motion, rhythm.
- (d) Reproductions: stereo, electro, nickeltype.

3. Colour:

- (a) Purpose, value, effect, number of.
- (b) Display considerations: legibility, making sense, completeness.
- (c) Mechanical factors: splitting the form.

4. Advertisements:

Financial, product, entertainment, travel, chain and departmental store, and general, analyzed as to characteristics and traditions.

5. Press Work:

The work of Grade XI to be reviewed and expanded as facilities will permit. Practical applications required. These to be found on actual production of live jobs for school use.

SHEET METAL

1. Pattern Development:

- (a) An extension of the parallel line and projection methods of developing patterns for round and rectangular pipe and duct fittings, skylight curbs; common, ridge, hip and jack bars; conductor heads and finials; cornice mitres (face and return); intersections on irregular surfaces.
- (b) Radial line development: round and rectangular eccentric tapers, stack heads, rectangular Y's and offsets, guards for machine belts and gears.
- (c) Triangulation: eccentric transition fittings, machine and forge hoods, Y-branches from round pipes of equal and unequal angles and diameters, rectangular Y-branches with different areas for ventilation systems, regular and compound offsets.

NOTE:—All patterns for pipe and duct fittings to entail the use of seams commonly used in the fabrication and assembling of blower and ventilation systems.

2. Seams and Joints:

- (a) Blower and ventilation systems: all seams involved in the fabrication and assembling of ducts, etc., such as riveted, slip double seam, built-up hammered lock, drive cleat, S-cleat, standing seam and slip lock.
- (b) Roofing and ceiling: cross and longitudinal joints for flat lock, standing seam and batten roofing; expansion joints for eavetroughs, box gutters and roofing; types of joints used on manufactured metallic ceiling, roofing and siding.

3. Oxy-acetylene Welding:

Care and use of tanks, gauges, hose, torch tips and valves; setting up and assembling outfit; lighting and regulating flame; welding and brazing light sheet steel and small structural shapes used in reinforcing and bracing sheet-metal tanks.

4. Machine Operations:

- (a) A more extensive use of the bending brake in forming eavetroughing, cornice and copings; the use of special forming attachments for the brake.
- (b) A wider use of the small machines (elbow edging and setting down, wiring, turning and burring) in the fabrication of pipe fittings; adjusting heads for end-play; correct position for various gauges of metal used.
- (c) Foot squaring shears: replacing, lining up and adjusting blades for shearing light and heavy metals.

5. Hand Operations:

Raising, bumping, planishing, dressing; stretching and shrinking edges.

CABINET-MAKING

Projects are to be selected that require the general use of cabinet tools. Some special attention is to be given to the construction and use of plywood and the matching and laying of veneer. Some elementary instruction in hand carving is to be given and should include the use of veiner, fluter, gouge and vee or parting tool.

1. Materials:

A study of foreign and native woods used in the cabinet trade; grades and methods of grading lumber; types of cut or sawn veneers.

2. Hand Tool Operations and Construction:

- (a) Tables (ends): solid and panel construction assembling.
- (b) Frames, undertops and parting rails in case construction; construction of drawers.
- (c) Gluing, clamping and squaring case goods.
- (d) Jointing and taping plain veneers.
- (e) Matching, jointing and taping face veneers.
- (f) Gluing up core, crossband and face veneer (plywood).
- (g) Veneer press: use of cauls (metal, wax paper or wax plywood parting pieces used in the press when gluing up to prevent individual units of plywood from sticking together).
- (h) Repairing checks or blisters on veneered stock.
- (i) Cutting and applying an overlay.

3. Machine Tools and Operations:

- (a) Cut-off saw: fitting, setting, jointing and filing.
- (b) Variety saw: gumming, setting, jointing and filing a rip saw; filing a dado saw; cutting concave with offset ripping fence.
- (c) Jointer and planer: grinding and setting knives.
- (d) Shaper: shaping to form; fluting; knife layout.
- (e) Router: set-up and adjustment; use of pin in routing to a pattern.
- (f) Band saw: fitting and brazing; resawing.
- (g) Belting: methods of joining; principles of drives; principles of proper tracking.

4. Upholstering:

Box seat construction: springing up; webbing.

5. Finishing:

- (a) Stains: selection and mixing, highlighting and blending.
- (b) Filler: colouring; shellac cutting and colouring; dull satin and gloss finish.
- (c) Preparation of polish.
- (d) Varnish remover; refinishing; repairing (indented) finish.

CARPENTRY

The course is to include a more advanced study of the operations of Grade XI. Reading of plans, writing specifications, material cost, and a study of local municipal building by-laws are to be included.

1. Laying Out Site:

Use of batter boards; running lines, driving pegs; squaring by use of triangle and equal diagonal methods; levelling by the use of pegs and straight edge.

2. Bench and Mill Work:

- (a) Fitting a mortise lock, fitting lock striker, necessity and method of reversing action of lock, setting butt hinges, solid and loose pin.
- (b) Laying out porch steps; laying out stairs with winders; setting risers, treads, newel post; method of laying out bull-nose tread.
- (c) Method of making window-frames, window-sash; position of stiles, rails and muntins; storm sash; making a coped joint.

3. Construction:

- (a) Sill, joist and girder positions for brick and frame construction; studding; inside and outside sheathing (butt joint and shiplap).
- (b) Roof terminology; open and box cornice; grades of wood and asphalt shingles, method of laying; valley gutters and flashing; setting and fitting metal ridge roll on hip and ridge; use of framing square in laying out gambrel roof.
- (c) Scaffolding and roof appliances used in the course of construction.

4. Interior Trim:

Flooring (heavy and thin type), base-board, quarter-round, door jambs and casing, plinth, panelling and plate rail, picture mould, plain and mantel trim, fitting and nailing, scraping (hand and machine), sanding, seasoning; mitred and coped joints.

PATTERN-MAKING

1. Study of Materials:

Specifications for pattern supplies, sources, rules in buying, nomenclature.

2. Planning:

- (a) Pattern layout to show moulding procedures and machining.
- (b) Special pattern markings such as stop-offs, fillets, and loose pieces.
- (c) Adjustments in design of patterns for machining castings such as addition of lugs and bosses.
- (d) Storing and recording patterns.
- (e) Determine weights of castings from patterns and drawings.

3. Hand Tools:

Cutting tool design and angles; advanced tool technique.

4. Machine Tools:

- (a) Specifications for machine tools for woodwork; design of blades and cutters.
- (b) Machine speeds, cutting speeds.
- (c) Special cuts and jigs for machine work.
- (d) Discussion of pattern-making power tools for special work such as milling and gear cutting.

5. Types of Constructions:

- (a) Box and frame constructions including patterns of shell types built on forms; core boxes of same type having loose piece features with core prints attached by joints.
- (b) Patterns and core boxes of laminated construction such as ring forms, segmental work, wheel constructions presenting use of tongue joints; rechucking rims of circular section; matched parted patterns; turned core box cavities.
- (c) Formed patterns with irregular parting line; loose flange application with slab core such as offset pipe work.
- (d) Stave construction and turning.
- (e) Sweeps and templates for loam and plaster of paris patterns.
- (f) Master patterns: contractions, finish; metal patterns and working patterns.
- (g) Match plates: wood, metal, cast plates; attaching patterns to plates, forming and disposition of gates and runners; layout for one-sided plates, double-sided plates, irregular parting line plates; discussion of common types of moulding machines used in plate work.

6. Foundry:

- (a) Types of flasks: shaped, match plate, crane.
- (b) Use of chaplets: types, securing cores.
- (c) Suspended cores, cake and cover cores, draw backs.
- (d) Use of follow boards and match plates.
- (e) Green sand moulding with shell patterns.
- (f) Dry sand moulding, use of sweeps, loam moulding and core-making.

FARM MECHANICS

1. Drawing and Plan Reading:

- (a) Detail drawings of farm appliances such as bins, stalls, chutes, balers, work benches; timber roof trusses; culverts.
- (b) Sketches and working drawings of parts of farm implements from measurements made of the part.
- (c) Sheet metal drafting:
 - (1) Developing patterns for simple sheet-metal devices such as ventilators, T-pipes and elbows.
 - (2) Laying out mitre cuts for eavetroughs, cornices, ridge rolls and gutters.

2. Woodwork:

- (a) Tool sharpening: grinding, filing and whetting edge tools of any shape such as gouges, veining tools, auger bits, twist drills.
- (b) Construction and repair:
 - (1) Roof framing to include the use of the framing square to lay off common, hip and jack rafters, and straight stairs.
 - (2) General maintenance repairs.

3. Painting and Finishing:

The work of Grade XI extended with emphasis on the preparation of surfaces (new and old).

4. Forge and Sheet Metal:

- (a) Bending, shaping, welding and tempering operations used in making more difficult farm articles, and in repairing broken parts.
- (b) Construction and repair of sheet-metal objects such as tanks, ducts, hoppers and eavetroughs.

5. Farm Implements:

Dismantling, assembling, fitting, replacing, and renewing parts of farm machinery such as pumps, windmills and gears and bearings of implements.

6. Concrete Work:

- (a) Care and theory of operation of concrete-mixing machines.
- (b) Construction and use of irregular wood and metal forms.
- (c) Reinforcing and testing concrete.

7. Motor Mechanics:

An extension of the Grade XI course applied to field maintenance and emergency repairs of tractors, stationary engines and trucks.

